Ives (C. L.)

A SKETCH OF HUMAN EMBRYOLOGY,

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To instruct, or to interest should be the aim of an Essay presented to this Society. The former is not within the province, nor often the ability, of a Junior in the Profession; the latter is the more appropriate object of his endeavor. With this view, I have selected a topic of but little practical value, and yet one, I conceive, of unusual interest to all. I propose to lay before you, briefly, the Development of the Human Embryo.*

Omne vivum ex ovo—that every living thing comes from an egg is a maxim of Physiology now universally received. Where do we find the egg to which Man may trace his origin?

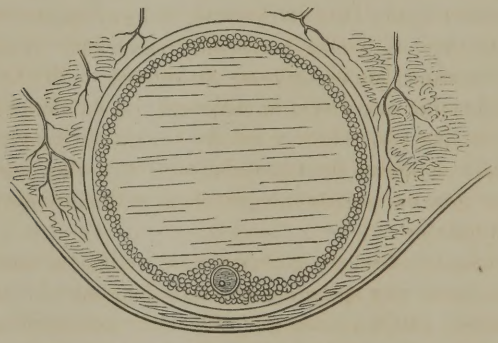
Down within the ovary of a human female is an almost imperceptible cyst. It has lain there in quiet, perhaps for years. But the vital force, so long dormant, at last arouses it to action. It begins to enlarge, new forms appear in its interior, it gradually makes its way outward. Reaching, at length, the surface of the ovary, the cyst bursts, and its contents are discharged. A minute vesicle, invisible save to the microscope, is thus set free, and falls into the embrace of the Fallopian tube. Carried down this channel by peristaltic and ciliary action, it enters, and slowly traversing the uterus, is finally, with the secretion of that organ, cast out and lost—an aborted ovum.

Another month rolls by; another cyst matures, is ruptured, and exudes the vesicle it enclosed. More fortunate than its predecessor,

* In submitting this paper to publication, the writer desires to disclaim any pretension to originality. His only endeavor has been to present to his brethren of the County Society, a simple, concise, and at the same time intelligible account of the more prominent points of Human Embryology, which require, for their comprehension, a patient study of details in the larger Physiological Works.

this vesicle, ere it commences its journey, encounters certain spermatozoa, which have found their way hither after recent intercourse. From these ciliated cells, which are believed to pass in bodily form into the interior of the ovum, the peculiar element of the male is received, and thus the act of impregnation is mysteriously consummated. The ovum is now complete, the egg has been fecundated. Although unchanged in outward form, there has been implanted within a principle of progressive life. In this minute vesicle may now be found the germ we seek. Henceforth, under favoring circumstances, it undergoes a development of surpassing interest and importance; from which, at length, there emerges upon the world, a being of that race which originally was created in the image of its Maker.

Let us now review our steps. That enlarging cyst within the ovary is a *Graafian follicle*, so called, attaining when ruptured an average diameter of the sixth of an inch. It consists of a fibrous membrane, enclosing a clear yellowish fluid. At maturity, this envelope is lined everywhere on its interior by an epithelial layer of cells. About the point nearest the surface of the ovary, where the subsequent rupture occurs, these cells are accumulated into an eminence looking inward, embedded within which is *the Ovum.*



(After Coste.) Section of mature Graafian follicle, within tissue of the ovary, showing the ovum embedded in epithelial layer of cells.

This is a spherical vesicle 1-120 inch in diameter, with a transparent membranous envelope of unusual thickness. The opaque yelk-mass, partly fluid, partly granular in its interior, contains a nucleated cell known as the *geminal vesicle*, or germ cell, which is present in the ova of all animals, and is the portion earliest developed. As the ovum escapes from the Graafian follicle, it carries with it the adherent cells forming

the eminence, which, however, are soon detached, leaving the exterior round and smooth. Upon this there is deposited, during its passage through the Fallopian tube, a gelatinous layer secreted from the inner lining of that canal, and overlying this there is formed from the same source a fibrous membrane, the *Chorion*. A deposit of carbonate of lime upon the outer layer of the chorion, forms the egg-shells of birds. But in mammals the chorion acquires a shaggy coat of villous projections, through which nutriment is absorbed until the completion of the Placenta.*

Arrived at the uterus, the ovum finds extraordinary preparations made for its reception. The mucus membrane of that organ is greatly thickened, its tubular glands enlarged, its blood vessels increased. To this hypertrophied mucus membrane, the name of *Decidua*, or the deciduous coat, is given, because it is shed with the product of each conception, being renewed shortly after. Into this spongy bed the ovum falls, and the luxuriant Decidua, apparently receiving a new impulse from its presence, sprouts up around and finally completely envelopes it; the portion thus growing over it being known as the Decidua Reflexa; while that remaining between the ovum and the muscular wall of the uterus, and elsewhere lining its interior, is styled the Decidua Vera. With the increase of the ovum, the Decidua Reflexa is carried nearer to the Decidua Vera of the opposite uterine surfaces, till, about the close of the third month, the two come in contact. It should be remarked that the mucous membrane of the Cervix takes no part in forming the Decidua, although its follicles enlarge and secrete the mucous plug which closes the Cervix during pregnancy.

Having now deposited the egg in its nest for a nine month's incubation, let us give our attention to the changes that are already transpiring in its interior.

That germinal vesicle, the germ cell constituting the nucleus of the ovum has, in some way not yet understood, disappeared. In its stead, we find another, called an *embryo cell*, which soon divides into two cells; these two, by a similar bisection, become four; these four, eight,

* It should be borne in mind that the yelk of the bird's egg, beside the small portion which alone is formative, is mainly composed of nutriment, stored up for the embryonic life of the individual. Indeed, in the earliest stages of the ovarian development of these ova, the germinal portion is temporarily collected within a spherical membrane, (presenting thus an analogue of the Mammalian ovum,) and upon this the nutritive portion is superadded. It would seem then, that the Graafian follicle of the mammalian, with its contents, is the strict analogue of the whole ovarian ovum of the bird.

and so on, till, by a repeated subdivision, an indefinite number of such cells have been produced. At the same time a like process of cleavage goes on in the yelk. Each of the newly formed embryo cells now draws about it a segment of the divided yelk, and around this a membrane forming, we have thus a complete cell of which the embryo cell now enclosed becomes the nucleus. This process goes on till the bulk of the ovum has been resolved into a mass of such cells. These cells, as formed, pass forthwith towards the exterior of the ovum, (a clear yellowish fluid being left within,) and there unite to form a spherical membrane, called the *germinal membrane.**

Observe now the relation of parts. Beginning at the center, the constituents of the ovum are, first, the fluid yelk, directly enclosing which is this germinal membrane; exterior to which, though with a slight interval caused by the shrinking of the consolidated yelk, is the original envelope of the ovum; then comes the albuminous envelope acquired in the Fallopian tube; and outside of all, the shaggy chorion.

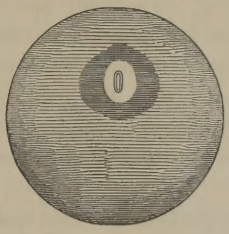
The germinal membrane soon divides into concentric layers, three in number. First, the *exterior or serous* layer, in which are developed the bones, the muscles and nerves. Second, the *middle or vascular* layer, in which the blood vessels are developed. Third, the *innermost or mucous* layer, in which is developed the nutritive apparatus.

Watching the course of embryonic development, we soon learn that a primary step in the formation of any structure seems to be a thickening or clustering together of cells, at the point where the structure is to appear. Accordingly, we find in the germinal membrane, at one portion, a dark, roundish spot, extending through all three layers, which is caused by an accumulation of opaque cells. This thickened portion is denominated *area germinativa*, the germinal area, because within it the first appearance of the germ is detected. The center of this dark spot soon clears up, and to this transparent portion is given the name *area pellucida.* Outside of the pellucid area a circular margin of opacity still remaining is called *area vasculosa*, from the

* The segmentation of the yelk may be otherwise, perhaps more simply explained without the intervention of the first mentioned embryo cell. As from parent cells a progeny of young cells, developed in their interior, are brought forth, so the elementary granules, within the germinal vesicle, developed into mature cells, may rupture their envelope and be scattered over the yelk. And, in the segmentation of the yelk then ensuing, each may directly become a nucleus of the compound cells which go to make up the germinal membrane.

fact that here the first blood vessels originate, within the middle of the three layers of the germinal membrane.

It may be premised that the embryo is developed with its back to the exterior of the ovum, its front aspect presenting internally, and we may perhaps refer to these relations, before that, according to the use of the term in the outer world, the youngster can properly be said to have a backside.



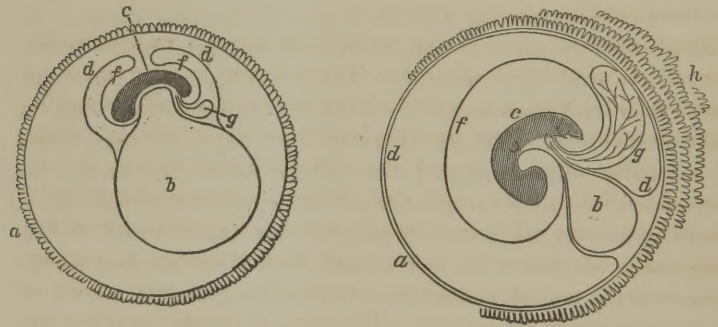
Exterior view of the Germinal Membrane, showing the Area Pellucida surrounded by the more opaque Area Vasculosa. In the center of the former is seen the germ.

The first appearance of the embryo is in the center of the area pellucida, within the external layer of the germinal membrane. It consists of two straight, parallel elevations or thickenings of this layer, called the *dorsal laminæ*, between which is a shallow groove, known as the primitive trace. The dorsal laminæ, by a continued accumulation of cells, gradually sprout, as it were, upward for a little way from the surface of the germinal membrane, and approaching each other, finally unite over the groove, so as to convert it into a tube. Within this tube is laid the brain and spinal cord. By a precisely similar process in the mucous or innermost layer of the germinal membrane, thickening, sprouting out, (in this case towards the center of the ovum,) and arching together, a simple tube is in like manner formed in opposition to the tube just described in the serous layer, from which it is separated by the intervening vascular layer. This is the rudiment of the alimentary canal. The dorsal laminæ, (the thickened portion of the serous layer,) now send prolongations inward, in the same manner as, though in an exactly opposite direction to, those before sent outward. These dipping down into the yelk, puckering the germinal membrane on each side into a fissure or fold, approach each other and finally unite around the rudimentary intestine in the central line of the front of the body. The vascular or middle layer, from its position beneath the serous, is carried around with it to the

line of junction, and it is through this layer, in the linea alba, that the blood vessels pass out temporarily to the yelk, and afterward to the Placenta.

Look now at this rudiment of a fetus,—two closed, nearly straight tubes, lying one above the other, upon the exterior of the yelk sac the outer, the spinal canal, formed of the serous layer of the germinal membrane; the inner, the alimentary canal, formed of the internal or mucous layer, but with an investiture of the vascular and serous layers embracing it. The yelk, by the junction in the linea alba of the two inner processes of the dorsal laminæ has been pinched off from the hitherto open abdomen of the germ. To this yelk sac, the walls of which are, of course, the germinal membrane originally investing it, the name of *umbilical vesicle* has been given. It gradually disappears as its contents are absorbed for the nutrition of the germ.

But we have now to record still another formation from the serous layer, caused by the same process of elevation and arching to a junction.



(From Carpenter.) Diagrams of Ovum, in different stages of the formation of Amnion; a, Chorion; b, yolk enclosed by germinal membrane; c, embryo; d, external, f, internal folds of the serous layer forming the Amnion; g, Allantois; h, villi collecting into Placenta.

This layer rises up in a double fold on each side of the germ. Retaining still their membranous character, the folds from each side at length come into apposition over the back of the embryo. By an absorption of the line of contact, the exterior layer of one side joining with the exterior of the opposite, and the interior with its fellow, two separate concentric membranes are thus formed around the germ.

The outer envelope expanding in both directions from its points of attachment beside the germ, its advancing line forming a curve from

the yelk to the chorion, invests the inner aspect of the chorion, and at the same time the outside of the yelk sac. But these prolongations traveling around the yelk, at length meet on the side opposite to the germ. An absorption here again occurs in the line of union, separating the membrane thus into two portions, the one, as before explained, lining the inside of the chorion, the other, the outside of the yelk sac. Into the space thus vacated between the yelk sac and the chorion, the interior membrane in like manner advances to pursue the same development; but its external portion, failing to attach itself to the chorion, becomes a separate investing membrane to the ovum, and is known as the *Amnion;* while the inner portion forms an additional envelope to the yelk.

Up to this time the embryo has been nourished by direct absorption; but a more speedy and extensive distribution of nutriment from the yelk to the growing tissues is now required. To supply this need blood vessels are created. Their first appearance is within that margin of opacity bounding the pellucid space, denominated the vascular area; in the middle, the vascular layer of the germinal membrane. The first blood discs are thought to be the nuclei of cells, which unite end to end to form the first vessels.

Blood is first observed as fine points in the vascular area, which are soon united by delicate channels. These minute capillaries empty into a larger circular sinus, bounding the vascular area, which with its tributary capillaries gradually extends over the whole yelk sac. From this sinus the blood is carried into the embryonic system, for the researches of Von Baer prove that the first motion of the blood is *towards* the heart. The first vessels are therefore veins, whose formation succeeds that of the blood, which itself is formed, as you perceive, in the germinal membrane investing the yelk, and outside of the body proper of the embryo. The blood, in this way sent into the system, passes to the embryonic heart, and is returned by arteries, which thus complete the circuit.

But the supply of nutriment in the human yelk is exceedingly limited, and more permanent provisions are soon required. It is also requisite to depurate the blood, circulating through the growing tissues, of the carbon with which it is fast becoming charged. The function of respiration, therefore, is at this early day to be provided for.

To meet these wants an offset from the intestinal tube is observed sprouting outwards near the caudal extremity of the embryo, between the inner and outer amniotic folds of the serous layer. It is a hollow

vesicle known as the *Allantois*, which, before the amnion has completely invested the yelk and the embryo, continues its growth outwards till it reaches the chorion. Upon its parieties are extensive ramifications of blood vessels, afterwards known as the umbilical arteries and veins. In the ovum of birds, the allantois becomes a highly vascular, permanent membrane, spreading itself along under the chorion, till the whole egg is invested. Acting in the place of fetal lungs, it presents the carbonized blood to the influence of the atmospheric air, which transudes through the porous shell. In mammals, on the other hand, it serves a temporary purpose of acting as a ladder, or rather an elongating balloon, by which the umbilical vessels may climb to the placenta or fetal lungs of this class. Soon after the portion exterior to the body dwindles away to a mere cord, scarce detectible among the other constituents of the umbilical cord. But the portion within the abdomen is retained to serve an important purpose. It becomes the urinary bladder, and the remains of the allantois, as it passed out, are still to be discerned in the urachus, or suspensary ligament of the bladder, which connects that organ with the umbilicus.

By this time, the umbilical vesicle, with its circulatory system, has disappeared, and the fetus is now nourished entirely from the *Placenta*. To form this organ, the villi, by which the chorion is invested, are multiplied and enlarged in that portion to which the umbilical vessels ascend, and by capillaries of the latter, are plentifully supplied with fetal blood. These villi extend into the follicles of the decidua, whose hypertrophied veins form sinuses of considerable size. By the lining membrane of these sinuses, the protruding villi are enveloped, in the same way as the intestines are covered by the reflected peritoneum; in which illustration the abdominal cavity would represent the cavity of a sinus. In this cavity then, the fringing surface of the villus, with its interior capillaries, lies bathed in a current of maternal blood. So that the placenta is composed of a fetal and a maternal portion, closely enfolding each other, between which, however, none but an endosmotic communication exists, as is shown by the differing size of the blood discs in the two circulations.

Let us now study the arrangement of vessels by which the fetal circulation is henceforth carried on. To go back a little. The heart, whose formation is subsequent to, and distinct from that of the blood, is developed from a mass of cells, of which those in the interior liquify to form a cavity. It is originally a simple, straight tube, extending nearly the whole length of the embryo, its posterior portion

being the auricular, where, from the first, prolongations are observed to meet the veins coming in from the vascular area. From the anterior portion arteries are given off. At this stage the heart presents the type found in the Articulata, to which the insect tribe belong. Soon a construction near the middle divides the dilating auricle and ventricle, between whose hitherto synchronous pulsations a slight interval is now detected. Gradually, in the ventricular portion, the tube bends completely upon itself, the resulting angle forming the heart's apex. We have now the heart of the fish, a single auricle, a single ventricle and one aorta, at whose origin we find a dilatation, the bulbous arteriosus of that class. Ere long a septum divides the entire heart into two distinct organs; an opening, the foramen ovale, remaining, however, between the auricles till after the close of fetal life.

Trace up now the single aorta. Passing along the neck in front of the developing trachea, it gives off at regular intervals, four or five horizontal branches to each side. These, at the same interval, empty themselves into two systemic aortas, which pass down one on each side of the pharynx and converge to a junction near the last dorsal vertebræ. An analogue to the permanent distribution in fishes, and which may be considered as the primary type for the Vertebrata. In fishes a further development of gills upon the horizontal arches takes place.

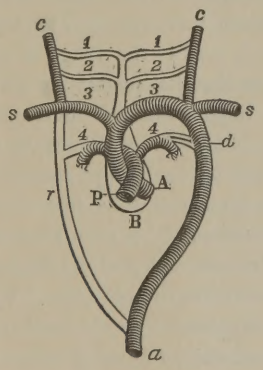


Diagram of the formation of the arterial trunks. A, ascending, a, descending aorta; B, bulbous arteriosus; c, c, carotids; s, s, subclavians; P, pulmonary artery; d, ductus arteriosus; 1, 2, 3, 4, first to fourth pair of arches; r, right systemic aorta, (obliterated.) Portions in outline are temporary; those shaded are permanent.

But in man, the uppermost pair dwindle away; so do the second. The third remain, and continued into the subclavians, supply the upper extremities. The fourth pair, on their way to the systemic

aortas, send branches to the lungs. The upper portion of the bulbous aorta, which gives off the first two pairs of arches, disappears with them down to the origin of the third arch. The systemic aortas, into which they emptied, still remain on both sides of the neck above the third arch, as branches of the latter, and, under the name of the carotids, supply the head. But on the right side, the systemic aorta below the third arch down to its junction with the other aorta becomes obliterated, and the left aorta is henceforth obliged to transmit all the blood sent to the lower extremities. It enlarges and becomes *the* descending aorta, being connected to the bulbous or ascending portion by the intervention of the third arch, which is now recognized as *the arch* of the aorta. As the carotids and subclavians arise from the third arch, we shall find them on the right separated from the aorta by the third arch, which anatomists call arteria innominata; but on the left we find them springing directly from the aorta, which as before explained, is itself the original third arch of that side.

But the septum between the ventricles of the heart enlarges, extends up into the bulbous aorta, dividing it into two tubes, which lie at first side by side, afterward bending somewhat around each other. The one continuous with the right ventricle is known as the pulmonary artery,—that with the left becomes the common, the ascending aorta. To the latter the third arches are attached,—from the former the pulmonary aorta, the fourth pair arise. The fourth arch of the right side, beyond the branch sent to the lungs, is obliterated with the old, right systemic aorta, so that its remaining portion is ramified simply upon the embryonic lung. The left fourth arch, on the other hand, till the close of the fetal life, continues to empty into the aorta. The part of it, however, between its pulmonary branch and the aorta, known as the ductus arteriosus, falls into disuse at birth, when the lungs assume their function, and is soon after obliterated.

From the hypogastrics, branches of the iliacs, the umbilical arteries, two in number, are sent off to the placenta. By them is conveyed the blood which is to be depurated by endosmotic exposure to the aerated blood of the mother, and which returning brings back nutriment for the developing fetus. Tracking the arterialized blood from the placenta through the single umbilical vein, we find it entering the abdomen, and passing into the portal vein, part is sent through the capillaries of the liver, ere long reaching the heart through the hepatic vein, while the rest by a short cut, the temporary ductus venosus into the hepatic vein, is carried direct to the heart. The red blood entering the right auricle from below, passes through its back part, being

directed by the Eustachian valve through the outer auricular opening into the left auricle. Thence through the left ventricle and ascending aorta it is distributed to the brain and the system at large. While the red blood is thus as it were stealthily conveyed through the right auricle, a current of black blood from the superior cava is pouring down in front of it, through the same auricle into the right ventricle; thence into the pulmonary aorta, which through the ductus arteriosus conveys it into the descending systemic aorta. So that below the ductus arteriosus the fluid in the aorta is a mixture of arterial and venous blood, while that sent off antecedently, supplying the brain and upper extremities, is purely arterial, or nearly so. An economical provision this, to furnish the more highly vitalized blood to the more important or first developed parts. It will be observed that practically during fetal life the ventricles act as one, throwing their blood each into the systemic aorta, although in different portions of it, thus bearing a resemblance to the reptilian type in which we have one ventricle and two auricles.

Veins corresponding to the so called cardinal veins of fishes follow the course of the spine, one on each side, which in extra-uterine life remain, as the jugular veins above, the azygos below, the heart. Of the two superior cava formed at first by them, as in lower animals, the left is obliterated, the blood from the jugular and azygos of that side being conveyed into the right by a transverse arch across the top of the thorax.

So much time has been spent upon the circulatory system that it will be impossible further than to allude to the remaining details of development. The transition from a simple, straight tube to the completed form of the Alimentary Canal is of a nature to be readily appreciated. The Liver, originating in a mass of cells in the wall of the intestine, is gradually evolved into a gland and carried further from its source, until the elongating and narrow attachment becomes the hepatic duct. The Lungs are similarly formed of two bud-like processes from the upper part of the alimentary canal.

In the development of the Urinary Apparatus we find the two kidneys preceded by temporary organs, the Wolffian bodies, which are permanent in the lower types of animals. These are highly vascular, though simple cœcal appendages, along a lengthened tube, which empties directly into the allantois. They shrivel away as the kidneys become developed, till at birth they are scarce discerned, being found in the male near the testes. The kidneys, which originate near the Wolffian bodies, are in no way connected with them

farther than that their excretory duct empties into that of the former organs. To the supra renal capsules, which surmount the kidneys, previous to the third month equalling them in size, no special interest attaches, unless it be because we know so little about them. The urinary bladder, formed as before explained, of the allantois, empties at first in common with the intestine into a cloaca, a fissure guarded by a sphincter, similar to the anus of oviparous Vertebrata. This, however, is soon partitioned off by septa, as we find it in the perfect fetus. The testis of the male, the ovary of the female, are originally formed in close connection with the kidneys, whence they descend to unequal distances, the testis reaching the scrotum generally about the ninth month. The efferent tube of the testis, at its upper extremity, forms a component part of that organ; while that of the ovary, the Fallopian tube, floats free in the abdomen, being attached to the gland only at intervals. The uterus is formed by the union of the lower extremity of the excretory ducts of the ovaries. In some of the inferior mammalia, where the union is not complete, the uterus is found horned, or even bifid through its entire length. In the male, the analogue of the uterus is found in the utriculus, or sinus pocularis, in the under side of the prostatic urethra, into which empty the vasa deferentia from the testes.

The development of the external generative arrangement is a subject presenting some curious points, which I can merely enumerate. Previous to the third month, the gender of the embryo is a matter of doubt. It can not be determined into the organs of which sex the rudiments already existing will resolve themselves. The germ-bearing gland near the kidney may become either testis or ovary. The nipple at the anterior portion of the anal fissure may be developed into an organ with glans, corpora cavernosa and spongiosum complete, or it may remain a clitoris, with those parts discernible, but still in a rudimentary state. Continued to its extremity, the canal from the bladder may form a lengthened urethra, or it may remain short and membranous. The fleshy prominences on each side of the anal fissure may be the labia, or uniting they may become receptacles for the testes, forming the scrotum with its well preserved line of junction. Indeed, the ovary has been found in the labium, which, during fetal life, communicates internally with the abdomen, and into which passes the round ligament, the correspondent of the gubernaculum testis of the other sex. But the problem yet remains unsolved,—"what decides the sexual character of these organs?"

The development of the osseous and nervous systems, presents many points of interest, but none of sufficient importance to warrant a further extension of the present paper.

And now, as briefly as possible, let me call attention to two or three lessons derived from a consideration of our subject. We learn that the process of development is from the general to the special, from the common type of the class to the peculiarities marking the individual. In the human embryo, we observe, as its earliest form, the common element of the animal Sub-kingdom to which it belongs, two simple tubes, the nervous cavity above, the digestive below. Upon this type-model of the Vertebrata are engrafted, first the distinctive features of the Mammalia, then those of the species, Man. The distribution of the arterial trunks is an interesting exemplification of special development from a general type. The archetype of the Vertebrata is composed of an ascending aorta, four or more horizontal, branchial arches, supplying two descending aortas, which soon coalesce into one. In the fish, its special development departs the least from the general type; gills are formed upon the arches. In the chick, its peculiar development, obliterating here, and there enlarging, brings out at last a descending aorta upon the right side, with the carotids and subclavians of both sides given off by a common branch from the aortic arch, while in man still another variation from the primitive form has been described.

But by no means is the assertion sustained, that the human embryo is carried forward, in its development, through all the lower forms of animal life, till it shall attain the higher and more perfect characteristics of its own species. It is true that in animals and in plants, life ever begins with a simple cell, similar in form though totally diverse in essence; but the moment that development has advanced to that degree that the human germ can be recognized as animal in its nature, then, in a nervous cavity separated from the digestive, it presents the essential feature which distinguishes the Vertebrata from the other divisions of the Animal Kingdom. It is true that in some of the details of development, in the structure of certain organs, the human embryo temporarily displays peculiarities of formation which are permanent in the lower organizations; but viewing it as an individual, we never find that vegetative repetition of similar parts, which characterizes the Radiata, never is it a mere bag of viscera to class it, for the time being, with the Mollusc, never a series of adhering joints to identify it with the Articulata; it is unquestionably, from the time any structure or shape is discernible, a vertebrated animal, it can be noth-

ing else. Nor are the distinguishing characteristics of the lower Vertebrata found in the human embryo. It is never a fish, a reptile, or a bird.

Again, we learn that cases of monstrosity, of malformations, will be caused by an arrest of development in any of the earlier stages of embryonic life. For instance, hare lip with cleft palate is but an imperfect junction of the forward processes of the dorsal laminæ. Abnormal distribution of the great vessels will result from arrested development at any of the steps we have delineated. Cyanosis is caused by a failure to complete the valve which, after birth, closes the inter-auricular opening. Hermaphrodism, apparent though not real, since the gender depends upon the germ producing gland, will arise from an unusually developed clitoris, want of union of the scrotum, retained testes, and the like.

But while the study of embryonic development explains many of the more obscure phenomena of animal life, it teaches an important truth to the reflective mind. Though our investigations be ever so profound, though we scrutinize ever so zealously the beginning of the new life, to find the cause which sets in motion that primordial cell; though with utmost diligence we examine each succeeding step to discern not only how, but why progress is maintained; our search is unsuccessful, there is something we can not penetrate, an agency all pervading, which yet eludes our grasp. As we discover marks of design, and a unity of plan in all these mysterious unfoldings in that hidden chamber of the animal organism; as we behold blind, unthinking matter hastening to obey a law itself could never have framed, we feel that we stand in the presence of a Being who speaks—and it is done. We can not see Him, our physical senses reach not His spiritual essence, yet, "His invisible things, even His Eternal Power and Godhead, are clearly perceived, being understood by the things that He has made."

And, while we study these progressive developments, we may derive an inference, which Revelation teaches as a truth. A further development, a still higher grade of Life, is in the Future to be attained by every one of us. These frail wasting bodies, these restless, ever changing frames of ours, are to experience yet one change more, before whose wonders all that precedes is not to be thought of. Not the gradual process of months or years of development, no intervention of second causes, but "in a moment, in the twinkling of an eye, the dead shall be raised incorruptible, and we shall be changed. For this corruptible must put on incorruption, and this mortal must put on immortality."